Multilayer PCB Antenna

Field of the Invention

The present invention relates to PCB antennas.

Background to the Invention

Bluetooth is a short-range wireless networking system operating in the ISM 2.4GHz band. The development of Bluetooth has required designers of disparate electronic devices to include rf circuitry for the first time and, in the case of mobile phones, additional rf circuitry. This of course can lead to undesirable increases in the size of devices to accommodate the electronics and the antenna or antennas required.

PCB antennas are disclosed in DE-U-29701589, GB-A-2237451 and US-A-5898404. However, in each of these documents the elements are formed from single layers of conductor.

Summary of the Invention

An antenna according to the present invention is characterised in that said element is formed from conductor patterns on a plurality of layers of a multilayer PCB, wherein the conductor patterns are in stacked relation and interconnected through the PCB.

The term "element" is not used herein as a generic reference to any structure but is used with the sense normally given in the field of antennas, for example in phrases such as "2-element Yagi" and "parasitic element".

Preferably, the element is located at the edge of the PCB. This reduces the amount of lossy PCB material in the vicinity of the antenna. Additionally or alternatively, the PCB may apertured adjacent to the element. This also reduces the amount of lossy PCB material in the vicinity of the antenna.

The present invention may be embodied in an inverted-F antenna comprising an F-shaped conductor pattern on a first layer of the PCB and an I-, L- or F-shaped

conductor pattern on the or each other layer, wherein the or each I-shaped conductor pattern is substantially coextensive with the "upright" of the F-shaped conductor pattern.

Preferably, the or each I-, L- or F-shaped conductor pattern extends along the edge of the PCB.

Preferably, the PCB is apertured, e.g. by means of a slot, between the "upright" of the F-shaped conductor pattern and a ground plane area.

An antenna ground plane may be provided by a plurality of vias connecting ground plane regions on respective PCB layers.

An antenna according to the present invention may be employed in a mobile phone.

Brief Description of the Drawings

Figure 1 is a block diagram of a mobile phone including an antenna according to the present invention;

Figure 2 illustrates the arrangement of an antenna according to the present invention on the main PCB of the mobile phone of Figure 1; and

Figure 3 is an exploded view of the antenna of Figure 2.

Detailed Description of the Preferred Embodiment

An embodiment of the present invention will now be described, by way of example, with reference the accompanying drawings.

Referring to Figure 1, a mobile telephone comprises an antenna 1, an rf subsystem 2, a baseband DSP (digital signal processing) subsystem 3, an analogue audio subsystem 4, a loudspeaker 5, a microphone 6, a controller 7, a liquid crystal display 8, a keypad 9, memory 10, a battery 11, a power supply circuit 12, a Bluetooth transceiver 13 and a Bluetooth antenna 14.

The rf subsystem 2 contains if and rf circuits of the mobile telephone's transmitter and receiver and a frequency synthesizer for tuning the mobile telephone's transmitter and receiver. The antenna 1 is coupled to the rf subsystem 2 for the reception and transmission of radio waves.

The baseband DSP subsystem 3 is coupled to the rf subsystem 2 to receive baseband signals therefrom and for sending baseband modulation signals thereto. The baseband DSP subsystems 3 includes codec functions which are well-known in the art.

The analogue audio subsystem 4 is coupled to the baseband DSP subsystem 3 and receives demodulated audio therefrom. The analogue audio subsystem 4 amplifies the demodulated audio and applies it to the loudspeaker 5. Acoustic signals, detected by the microphone 6, are pre-amplified by the analogue audio subsystem 4 and sent to the baseband DSP subsystem 4 for coding.

The controller 7 controls the operation of the mobile telephone. It is coupled to the rf subsystem 2 for supplying tuning instructions to the frequency synthesizer and to the baseband DSP subsystem for supplying control data and management data for transmission. The controller 7 operates according to a program stored in the memory 10. The memory 10 is shown separately from the controller 7. However, it may be integrated with the controller 7. A timer for triggering interrupts is also provided by the controller 7.

The display device 8 is connected to the controller 7 for receiving control data and the keypad 9 is connected to the controller 7 for supplying user input data signals thereto. Amongst other function, the display device displays the estimated extant life of the battery 11 by

The battery 11 is connected to the power supply circuit 12 which provides regulated power at the various voltages used by the components of the mobile telephone. The positive terminal of the battery 11 is connected to an analogue-to-digital converter (ADC) input of the controller 7.

The Bluetooth transceiver 13 is controlled by the controller 7 and sends and receives signals via the Bluetooth antenna 14.

Referring to Figure 2, the PCB 40 of the mobile phone has an upper end on which the loudspeaker 5 is mounted. The display 8 is mounted below the loudspeaker 5 and below the display is the keypad 9. The Bluetooth antenna 14 comprises an inverted-F antenna formed in a small strip-shaped region to the side of the keypad 9.

Referring also to Figure 3, the PCB 40 has first to eighth layers 40a, ..., 40h (shown with exaggerated thickness). The layers 40a, ..., 40h have respective ground plane areas 41a, ..., 41h. The ground planes 41a, ..., 41h are partially removed at the edges of the layers 40a, ..., 40h. However, an F-shaped region 42 of conductor is left on the first layer 40a. The "upright" of the F-shaped region 42 runs along the very edge of the first layer 40a with the "arms" directed inwards towards the ground plane 41a. Only the upper "arm" actually joins the ground plane 41a.

On the second to eighth layers 40b, ..., 40h, an I-shaped region 43b, ..., 43h of conductor is left along the edge under the "upright" of the F-shaped region 42 and coextensive therewith. The eighth layer 40h may be double sided and also have an I-shaped region on its other side.

The fourth layer 40d includes the feed 46 to the antenna which extends to a point under the shorter "arm" of the F-shaped region 42.

The "upright" of the F-shaped region 42 and the I-shaped regions 43b, ..., 43h are connected by a plurality of vias 52. This unites these regions which collectively form the radiating element of the Bluetooth antenna 14. Similarly, the feed 46 is connected to the shorter "arm" of the F-shaped region 42 by a via 47. A row of vias 51 unites the edges of the ground plane areas 41a, ..., 41h, which are substantially parallel to the "upright" of the F-shaped region 42, to form a ground plane for the antenna.

In order to reduce losses, two slots 48, are cut through the full thickness of the PCB 40. The slots 48 are located so that they are between the "upright" of the F-shaped region 42 and the ground plane on the first layer 40a, and extend parallel to the "upright" of the F-shaped region 42.

It will be appreciated that many modifications may be made to the above-described embodiment. For example, the I-shaped regions could be replaced with L-shaped regions which match the "upright" and upper arm parts of the F-shaped region or further F-shaped regions.

The antenna may be formed using other multilayer PCB structures, for instance three double-sided PCB layers (i.e. copper on both faces) may form the second to seventh layers of the antenna with single-sided PCB being used to form the first and eighth antenna layers.

Other forms of antenna, e.g. resonant dipoles, can be formed in a similar manner. Furthermore, multi-element antennas may be formed if directivity is a desirable characteristic. Additionally, a plurality of antennas by be formed on the same PCB or in the same way on different PCBs to provide path diversity, directivity or omni-directivity as desired.